

130W-1

INTROUCTION TO OXYACETYLENE WELDING & CUTTING

AG 130-W

UNIT OBJECTIVE

After completion of this unit, students will be able to operate oxyacetylene welding and cutting equipment safely and demonstrate basic oxyacetylene welds and cutting procedures. This knowledge will be demonstrated by completion of assignment sheets and a unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Pass a safety test on oxyacetylene welding.
2. Identify the basic components of the oxyacetylene welder apparatus.
3. Set up, use, shut off, and store an oxyacetylene welder properly.
4. Use the oxyacetylene equipment to braze mild steel.
5. Run a bead with the oxyacetylene equipment with and without filler rod.
6. Select welding rods and fluxes appropriate for the job.
7. Clean the orifices in welding heads using the approved technique.
8. Use the oxyacetylene equipment to perform three basic fusion welds.
9. Make a straight cut, using the cutting head.
10. Make a bevel cut, using the cutting head.
11. Pierce a hole in steel plate.
12. Clean the orifices in welding and cutting heads, using the approved technique.
13. Cut sheet metal (14 ga. or thinner) with the cutting head.

OXYACETYLENE WELDING EQUIPMENT AND SAFETY

A. Oxyacetylene Equipment Identification

1. Gas Cylinders

a. Oxygen Cylinders

1) Oxygen

- a) Oxygen is a colorless gas (20% of the atmosphere).
 - b) Oxygen has no smell or taste.
 - c) Oxygen is not a flammable or toxic gas.
 - d) Oxygen readily supports combustion.
- 2) Common size oxygen cylinders hold about 244 cu. ft. of oxygen at 2,000 to 2,600 lbs. per square inch (psi) pressure.
- 3) Because of their high pressure, they can explode if dropped, struck, heated, or arced with an arc welder.
- 4) The cylinder valve, which allows the flow of gas from the cylinder to the regulator, is protected when not in use with a threaded cylinder cap.
- 5) The cylinder cap has two holes on its side designed to cause a cylinder with a broken-off valve to spin instead of take off like a missile from the jet effect of the escaping, high pressure gas.

b. Acetylene Cylinders

1) Acetylene

- a) Acetylene is a colorless gas (a compound of carbon and hydrogen).
- b) Acetylene has a pungent smell due largely to impurities.
- c) Acetylene is flammable and highly explosive when mixed with oxygen.
- d) Acetylene is explosive when compressed above 15 psi, but is very soluble in acetone.
- e) Acetylene forms explosive compounds with silver and copper, so never use copper pipe or fittings with it.

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- 2) Acetylene cylinders are filled with a porous form of concrete in which all the air is removed by filling the pore spaces with acetone.
- 3) The acetylene can be stored in these cylinders at pressures above 15 psi without becoming unstable because it combines with the acetone under pressure.
- 4) Large acetylene cylinders can hold around 275 cu. ft. of acetylene at 250 psi.
- 5) If acetylene is withdrawn too quickly, removing all the available acetylene, the cylinder pressure gauge will read empty; but after the cylinder is not used for a while, more usable acetylene will come out of the solution.
- 6) Acetylene cylinders must be kept upright for about eight hours before use and during use in order to prevent acetone loss.

2. Gas Regulators

a. Gas regulators reduce the high cylinder pressures to low, hose pressures suitable for welding and cutting applications.

b. Identification of the Parts of a Gas Regulator

1) Inlet (cylinder valve connection)

- a) Oxygen inlets have right-handed threads.
- b) Acetylene inlets have left-handed threads and their nuts are notched on the outside.

2) Pressure Adjusting Screw

- a) Decreasing the pressure (out) is counterclockwise.
- b) Increasing the pressure (in) is clockwise.

3) Cylinder (high) Pressure Gauge

- a) Oxygen cylinder gauge reads 0-4000 psi.
- b) Acetylene cylinder gauge reads 0-400 psi.

4) Working (low) Pressure Gauge

- a) Oxygen working gauge reads 0-200 psi.
- b) Acetylene working gauge reads 0-30 psi.

5) Outlet (connection for hoses)

- a) Oxygen outlets have right-handed threads.
- b) Acetylene outlets have left-handed threads.

3. Check Valves

- a. Check valves allow the gases to flow in only one direction to prevent backflow.
- b. Check valves are necessary safety devices attached between the hoses and the regulator outlets.

4. Gas Hoses

- a. The hoses transport low-pressure gas from the regulator to the torch.
- b. The oxygen hose is always black or green.
- c. The acetylene hose is always red.
- d. The hoses are flame retardant, but should still be kept away from an open flame, sparks, molten metal, and slag.
- e. New hoses are stored with talcum powder inside, which should be blown out before connecting them to the torch.

5. Torch (Blowpipe)

- a. The torch controls the mixture of oxygen and acetylene to produce the desired flame.
- b. Identification of the parts of the torch:

1) Hose connections

- a) Oxygen connection is usually marked "OXY."
- b) Acetylene connection is usually marked "FUEL."

2) Oxygen control valve

3) Acetylene control valve

4) Barrel

5) Torch head

6. Torch Tips

- a. Welding tips
- b. Cutting tips
- c. Heating tips
- d. Tip cleaner

7. Protective Wear

- a. Goggles
- b. Leather gloves

8. Striker

- a. Hand-held piece of equipment used to produce spark.

9. Working Surfaces

- a. Welding table (fire brick does not explode under heat)
- b. Cutting table

B. Oxyacetylene Welding Safety

1. Preventing Eye Injury

- a. Wear goggles with the proper lens when welding, cutting, and grinding.
- b. Protect others' vision by using a welding shield.
- c. Make sure no one is standing in front of the cylinder valve before cracking it to prevent eye injury from blowing dust and grit.
- d. Make sure no one is standing in front of the gas regulators when turning them on to prevent injury from flying glass should they explode.

2. Preventing Burns

- a. Wear protective gloves, clothing, and boots (lace-up shoes can trap hot sparks, molten metal, and slag).
- b. Use a spark striker for lighting a torch, not matches or heated metal.
- c. Cool in water or mark your work "HOT" to keep others from touching it.
- d. Do not wear ragged clothes or cuffs on pants.
- e. Keep gloves and protective clothing free of oil and grease.

3. Preventing Respiratory Problems

- a. Ventilate the work area properly.
- b. Do not breathe the toxic fumes from welding or cutting galvanized material.

4. Preventing Equipment Damage

- a. Always use gas regulators to protect the hoses from the high cylinder pressure.
- b. Use tongs not the leather gloves to pick up hot metal.
- c. Do not over tighten hose connections and torch tips.
- d. Never lift cylinders by their valves.
- e. Never weld or cut on concrete; overheated concrete cracks and explodes.
- f. Be careful not to break tip cleaners off in the tip being cleaned.
- g. Keep hoses clear of the torch flame and dropping, molten metal when cutting.

5. Preventing Fire & Gas Explosions

- a. Never light a torch in an area full of feed or grain dust.
- b. Keep the area between you and the cylinders clear and the cylinder valves unobstructed.
- c. Keep oil and grease away from oxygen and oxygen connections.
- d. Do not try to find a gas leak with a flame; use soapy water from a soap that does not contain oil.
- e. Do not weld or cut on closed containers, tanks, or vessels.
- f. Never leave a lighted torch unattended.
- g. Never use the oxygen tank as a pressure supply to inflate tires or blow off surfaces.
- h. Always make sure the safety chain is attached and hold onto the oxygen cylinder when moving the cylinder truck.
- i. When moving or storing individual cylinders, always replace the caps to prevent valve damage.

ACTIVITY:

- 1. Identify all the components of an oxyacetylene welder.
- 2. Change lenses on welding goggles.
- 3. Take an oxyacetylene safety test.

OXYACETYLENE WELDING EQUIPMENT SET-UP & ADJUSTMENT

A. Oxyacetylene Equipment Setup

1. Cylinders

- a. Place the oxygen and acetylene cylinders side by side in a vertical position and secure them from falling.
- b. Remove the cylinder valve protection caps and store them for reuse later when the cylinders are empty.
- c. Check the cylinder valve threads to verify that they are in good condition and free of dirt and oil.
- d. Briefly "crack" the cylinder valves (slightly open) to blow out any dust or dirt that may be lodged there, so it does not enter the regulators.

2. Regulators

- a. Verify that the regulator inlet connection is free of dirt, oil, grease, or any other obstruction.
- b. Connect the oxygen and acetylene regulators to the proper cylinder valves using an open-end wrench, being careful to tighten the connection nut firmly without excessive force.
- c. Turn the regulator adjusting screw out (counterclockwise) on each regulator until it is loose.
- d. Stand to one side of the oxygen regulator gauge and open the oxygen cylinder valve slowly so the high-pressure regulator gauge needle gradually moves up to approximately 2000 psi if the cylinder is full, then open the valve completely.
- e. Slowly open the acetylene cylinder valve only one half turn, so it can be turned off quickly in an emergency. Acetylene cylinders read about 350 psi when full.

3. Hoses and Torch

- a. Connect the oxygen hose (green) to the oxygen regulator outlet and the acetylene hose (red) to the acetylene regulator outlet.
 - 1) The oxygen hose has right-handed thread connections.
 - 2) The acetylene hose has left-handed thread connections.
- b. Blow out the hoses with cylinder gas to remove dust, dirt, and talcum powder (used to protect new hoses in storage), which may plug the small gas passages in the torch.

- 1) Turn the adjusting screw on the regulators clockwise until 5 psi shows on the low (working) pressure gauge.
 - 2) Allow the cylinder gas to escape until the inside of the hoses are clean.
- c. Connect the free end of the oxygen hose to the torch connection marked "OXY" and the free end of the acetylene hose to the torch connection marked "FUEL."
 - d. Select the tip or nozzle size appropriate for the metal thickness (see welding tip selection chart), and only hand-tighten the tip to the torch.
 - e. Test for leaks by pressuring the system (described in paragraph B-1 below) and then brushing a non-detergent, soapy water on all the connections.
 - 1) Soap bubbles will indicate a leak; also listen for the hiss of escaping oxygen and try to discern the smell of acetylene.
 - 2) If a leak is found in a connection, retighten it or replace the faulty connection.
 - 3) Leaking cylinders should be returned to the supplier.

B. Adjusting the Torch

1. Pressurizing the System

- a. Close both control valves on the torch handle clockwise, finger tight only.
- b. Verify that the regulator screws are turned out and loose.
- c. Standing to one side of the regulator, slowly open the oxygen cylinder valve until the pressure gauge responds, and then open the valve all the way.
- d. Slowly open the acetylene cylinder valve 1/2 turn or one turn of the wrist.
- e. Open the torch oxygen valve 1/8 turn and then screw in the oxygen regulator valve until the desired working pressure is indicated on the regulator working pressure gauge. Close the torch oxygen valve.
- f. Open the torch acetylene valve 1/8 turn and then screw in the acetylene regulator valve until the desired working pressure is indicated on the regulator working pressure gauge. Close the torch acetylene valve.

2. Lighting and Adjusting the Torch

- a. Be sure all-protective clothing and goggles (No. 5 shaded lens) are on before proceeding to light the torch.
- b. Hold the torch in one hand and the striker (spark lighter) in the other.
- c. Open the torch acetylene valve no more than 1/4 turn and ignite the gas with the striker.
- d. Open the torch acetylene valve until the flame is no longer smoking.
- e. To set a carbonizing flame (excess amount of acetylene):
 - 1) Open the torch oxygen valve until a feathered cone exists in the flame.
 - 2) Three flame zones are present. They are the inner cone, the acetylene feather, and the outer envelope.
- f. To set a neutral flame (equal amounts of oxygen and acetylene):
 - 1) Open the torch oxygen valve until the acetylene feather disappears and only the inner cone and outer envelope exist.
 - 2) When the feathery edges of the inner cone disappear, a neutral flame is present.
- g. To set an oxidizing flame (excess amount of oxygen):
 - 1) Open the torch oxygen valve beyond a neutral flame to a point where the flame is pale blue.
 - 2) The inner cone will be shorter, will become slightly pointed, and the flame will be more noisy than the neutral flame.

C. Oxyacetylene Equipment Shut-down and Storage

1. Torch Shut-down:

- a. First, turn off the torch acetylene valve. If a small flame remains on the tip, the acetylene valve is leaking.
- b. Turn off the torch oxygen valve last.

2. Depressurize the system:

- a. Close both cylinder valves.

- b. Open the torch acetylene valve to depressurize the acetylene gauges and hose.
- c. Close the torch acetylene valve.
- d. Open the torch oxygen valve to depressurize the oxygen gauges and hose.
- e. Close the torch oxygen valve.
- f. Turn out the adjusting screws on the oxygen and acetylene regulator valves.

3. Storage of Cylinders

- a. Store cylinders in a well-ventilated, fireproof room or cage with flameproof electrical fittings.
- b. Do not store oxygen and combustible gases such as acetylene together.
- c. Store acetylene cylinders in an upright position--liquid acetone from within the cylinder can leak into valves.
- d. Write "empty" with chalk or soapstone on empty cylinders and keep them separate from full cylinders.
- e. Store cylinders away from sources of heat, since heat increases the pressure of gas and may weaken the cylinders.
- f. Store cylinders away from oil and grease, since these combustibles may ignite spontaneously when in contact with pure oxygen.
- g. Keep the cylinder caps on cylinders while in storage to prevent cylinder valve damage, which could result in an oxygen cylinder taking off like a missile.

ACTIVITY:

- 1. Set up oxyacetylene equipment.
- 2. Select a tip size using a tip chart.
- 3. Pressurize the system and light a torch.
- 4. Adjust for carbonizing, neutral, and oxidizing flames.
- 5. Dismantle the oxyacetylene equipment and put the cylinders in storage.

OXYACETYLENE FUSION WELDING

A. Oxyacetylene Fusion Welding Definition and Applications

1. Definition

- a. Fusion welding is the joining of metal pieces by melting them together.
- b. This is accomplished by heating the adjoining edges of metal to their melting point, allowing them to flow together, and then cool to harden as one piece.
 - 1) The combustion of the oxygen-acetylene gas mixture provides the heat for fusion.
 - 2) The flame from the combustion shields the weld from atmospheric contamination.
 - 3) A filler rod may be used to provide additional metal to help the two metal pieces join.
 - 4) The basic skill required in fusion welding is to form, maintain, and move a puddle of molten base metal along the weld, keeping it uniform in both size and shape.

2. Applications

- a. Fusion welding is used extensively for joining steel.
- b. Oxyacetylene fusion welding is usually applied only to thin steel.

B. Oxyacetylene Welding Terminology

1. Forehand Welding

- a. The filler rod precedes the torch in the direction of the weld.
- b. The filler rod and torch tip are both manipulated in opposite rotating directions.
- c. This is the best technique for welding metal up to 1/8 inch thick.

2. Backhand Welding

- a. The torch tip precedes the filler rod in the direction of the weld.
- b. Little or no manipulation of the torch tip and filler rod is required.
- c. This is the best technique for welding metal over 1/8 inch thick.

3. Welding Angles

- a. Work angle is the angle of the torch or filler rod perpendicular to the direction of the welding bead.
- b. Lead angle is the angle of the torch or filler rod parallel to the direction of the welding bead.

4. Base Metal (the metal to be welded)

5. Filler Rod

- a. It is a rod or wire of filler metal of the same composition as the base metal.
- b. A mild steel rod is used to weld mild steel; an aluminum rod is used to weld aluminum, etc.
- c. The diameter of the filler rod should equal the thickness of the base metal or bead.

6. Bead is the appearance of the finished weld, normally viewed as neat ripples formed by the metal while it was in its semiliquid state.

7. Tack Weld

- a. Tack welds are small, spaced welds along the weld joint made before running the continuous bead along the same joint.
- b. Tack welds prevent expansion or contraction of the weld joint during continuous welding.

C. Oxyacetylene Fusion Welding Procedures

1. Running a bead without filler rod (pushing a puddle)

- a. Prepare a piece of mild steel 1/8 inch thick.
- b. Use an 0 or 00 welding tip.
- c. Adjust the working pressures to about 3 psi for acetylene and 10 psi for oxygen.
- d. Wear appropriate protective gear, then light and adjust the torch to a neutral flame.
- e. Hold the torch at a 90 degree work angle and a 30 degree to 45 degree lead angle, with the inner cone of the flame 1/16 to 1/8 inch above the base metal.
- f. Hold that position over a spot just inside the right edge of the base metal until a molten puddle is established.
- g. Move the torch in a series of arcs or circles to make the puddle circular in shape and about 1/4 inch in diameter.

- h. Advance the torch from right to left across the base metal at a speed that will maintain a uniform puddle size and shape.
 - 1) If advanced too rapidly, the puddle will become too small and may be lost completely.
 - 2) If advanced too slowly, the puddle will become too large and may burn through the base metal.

2. Running a Bead with a Filler Rod

- a. The steps are the same as above until the molten puddle is formed.
- b. Once the puddle is formed, dip the end of the 1/16 inch diameter steel filler rod into the puddle and begin moving the torch in a series of vertical ovals, while at the same time moving the rod up and down, in and out of the puddle.
 - 1) As the flame rises, the rod lowers, and vice versa.
 - 2) Do not allow molten metal to drip from the end of the filler rod, but add the filler metal directly by dipping the end of the rod into the puddle.
- c. As the torch is advanced from right to left, maintain uniform bead width and height with a smooth ripple effect.
 - 1) If advanced too rapidly, the bead will become narrow and have the appearance of having been deposited on top of the base metal.
 - 2) If advanced too slowly, the bead will become too large and may burn through the base metal.

D. Oxyacetylene Welding Problems

1. Backfire (popping noise)

- a. Backfire is a momentary burning back of the flame into the tip ending with a loud pop (explosion at the tip).
- b. The causes can include the following:
 - 1) Insufficient gas velocity (open torch valves more).
 - 2) Overheated tip (hold tip farther away from the work or change the lead angle).
 - 3) Inadvertently moving the torch tip into the molten puddle (clean out the tip).

- 4) Sparks flying into the tip.
- 5) Improper seals or grommets within the torch (examine and replace).

2. Flashback (popping with shrill squealing or hissing)

- a. Flashback is an explosion occurring at the tip accompanied by gases burning back into the hoses and regulator.
- b. The symptoms are as follows:
 - 1) The flame goes out with a pop.
 - 2) A loud squealing or hissing noise occurs.
 - 3) Black smoke and sparks emerge from the tip.
- c. The action required to remedy the problem is as follows:
 - 1) Quickly close the torch valves and shut down the regulators and cylinder valves; allow the apparatus to cool.
 - 2) Do not relight until the cause has been found and remedied
- d. Possible causes could be any of the following:
 - 1) Clogged tip
 - 2) Improper oxygen-acetylene gas mixture ratio
 - 3) Loose connections
 - 4) Kinked hose

ACTIVITY:

1. Make a bead with and without a filler rod.

OXYACETYLENE BRAZING

A. Brazing

1. Brazing is the bonding (adhesion), rather than fusing (melting) of two metal objects.
2. This adhesion connection is made with a minimum of alloy (bronze) which melts above 800 degrees Fahrenheit and flows by capillary motion between close-fitting metal.
3. Brazing differs from braze welding in the following ways:
 - a. Brazing requires a very thin joint, as when overlapping sheet metal.
 - b. Braze welding joints resemble those of fusion welding; there is more bonding metal at the joint as compared to brazing.
4. Brazing can be used to join dissimilar metals.
5. Brazing can be used to join thin pieces of metal in order to decrease the danger of melting through.
6. Brazing can be used on most commercial metals, where oxyacetylene welding may have limitations.

B. Brazing Equipment

1. Brazing uses the same welding apparatus as oxyacetylene welding.
2. Flux required for bronze or brass brazing is usually a borax type consisting of sodium borate with other additives. (Flux is any substance or mixture used to promote the fusion of metals or minerals, for example, alkalis, borax, lime, fluorite, etc.)
 - a. Flux removes all oxides from the metal surfaces to be welded.
 - b. Flux forms a protective coating over the heated metal surfaces that prevents oxidation.
 - c. Flux floats the oxides and their impurities with which it combines to the top of the molten metal.
3. Bronze filler rods come in different sizes and have a lower melting point than the metal being bonded depending on their alloy composition.
 - a. Silicon bronze is used for copper sheet and mild steel.
 - b. Nickel bronze is used for mild steel, cast iron, and wrought iron.

C. Operating the Oxyacetylene Equipment to Braze and Braze Weld

1. Basic Brazing Technique:

- a. Set up the metal pieces to be joined.
- b. Select the appropriate torch tip.
- c. Adjust the torch to the appropriate gas pressures.
- d. Put on appropriate protective goggles and gloves.
- e. Light the torch with the striker and adjust the flame to slightly oxidizing.
- f. Heat the bronze filler rod with the torch flame and dip it in the flux so that it becomes coated with flux.
- g. Heat the area on the metal to be bonded to a cherry red color and "tin" it by applying a light coating of fluxed filler rod.
- h. After "tinning," finish the braze or braze weld by filling in the joint with a non-fluxed filler rod.

2. Brazing and Braze Weld Demonstrations

a. Overlap Joint (Brazing)

- 1) Overlap two pieces of sheet metal by approximately 1/4 inch.
- 2) Using the proper gas pressure and flame adjustment, "tin" the joint.
- 3) After "tinning," go back over the joint with a non-fluxed filler rod to smooth the joint.

b. Fillet Joint (Braze Welding)

- 1) Set up the two pieces of sheet metal at right angles.
- 2) Using the proper gas pressure and flame adjustment, "tin" the joint.
- 3) After "tinning," go back over the joint with a non-fluxed filler rod to smooth the joint.

ACTIVITY:

1. Bond sheet metal by brazing.
2. Bond mild steel plate by braze welding.

FOUR BASIC OXYACETYLENE FUSION WELDS

A. Corner Weld Without Filler Rod

1. Place two pieces of mild steel (1/16 inch thick) so that their edges form a 90 degree angle with their inside corners touching.
2. Select the appropriate tip by consulting a tip chart.
3. Adjust the working pressures to about 5 psi for oxygen and 5 psi for acetylene or according to manufacturer's recommendation for tip.
4. Wear appropriate protective gear, then light and adjust the torch to a neutral flame.
5. Tack weld the two pieces together:
 - a. Hold the torch at a 90 degree work angle and a 45 degree lead angle with the inner cone of the flame 1/16 to 1/8 inch above the base metal.
 - b. Place the torch over the two edges of the joint just inside the right corners of the base metals until a single molten puddle is established.
 - c. Remove the flame to allow the puddle to solidify.
 - d. Make another tack weld at the opposite end of the joint.
6. Play the flame on the right-hand tack weld to remelt a puddle on its surface, then advance the puddle from right to left along the joint at a speed that will maintain a uniform puddle size and shape.

B. Bead weld with filler rod:

1. Prepare a piece of mild steel 1/8 inch thick.
2. Select the appropriate tip by consulting a tip chart.
3. Adjust the working pressures to about 5 psi for oxygen and 5 psi for acetylene or according to manufacturer's recommendation for tip.
4. Wear appropriate protective gear, then light and adjust the torch to a neutral flame.
5. Hold the torch at a 90 degree work angle and a 45 degree lead angle with the inner cone of the flame 1/16 to 1/8 inch above the base metal.
6. Hold the filler rod in the outer part of the flame away from the joint until two tiny molten puddles begin to form on the corners, then add some filler metal from the rod to bridge the two puddles.
7. Continue to heat the puddle and add filler metal until the puddle is about 1/4 inch in diameter, then remove the flame to allow the puddle to solidify.
8. Using a forehand technique, advance the puddle from right to left at a speed that will maintain a uniform puddle size and shape.

9. Make sure that the filler rod is added only to the puddle, not just melting onto the pieces.

C. Butt weld with filler rod:

1. Prepare two pieces of mild steel 1/8 inch thick.
2. Select the appropriate tip by consulting a tip chart.
3. Adjust the working pressures to about 5 psi for oxygen and 5 psi for acetylene or according to manufacturer's recommendation for tip.
4. Wear appropriate protective gear, then light and adjust the torch to a neutral flame.
5. Tack weld the two pieces together so that they are spaced about 1/8 inch at the left and 1/16 inch at the right to allow for normal expansion from heating.
 - a. Hold the torch at a 90 degree work angle and a 45 degree lead angle with the inner cone of the flame 1/16 to 1/8 inch above the base metal.
 - b. Play the torch over the two edges of the joint just inside the right edges of the base metals until a molten puddle is established.
 - c. Hold the filler rod in the outer part of the flame away from the joint until two tiny molten puddles begin to form on the corners, then add some filler metal from the rod to bridge the two puddles.
 - d. Continue to heat the puddle and add filler metal until the puddle is about 1/4 inch in diameter, then remove the flame to allow the puddle to solidify.
 - e. Make another tack weld at the opposite end of the joint.
6. Play the flame on the narrower, right-hand tack weld to re-melt a puddle on its surface, then add metal from the filler rod.
7. Using a forehand technique, advance the puddle from right to left along the joint at a speed that will maintain a uniform puddle size and shape.
 - a. Make sure that the puddle melts into both pieces of metal at all times.
 - b. Make sure that the filler rod is added only to the puddle, not just melting onto the pieces.

D. Metal Behavior Under Applied Stress

1. Stresses are internal forces set up in the welded pieces due to heating and cooling.
2. Two types of stresses result from the welding process:

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- a. Stresses that develop while the weld is being made but which disappear on cooling.
 - b. Stresses that remain after the weld has cooled off (residual stresses).
3. There are several factors that affect distortion and residual stresses:
- a. Distortion (warping of the welded part) occurs if the expansion due to heating is resisted.
 - b. A residual stress results if the contraction due to cooling is resisted. Residual stresses can result in cracking of the welded part.
4. Methods of Reducing Distortion:
- a. Decrease the welding speed and use the smallest flame possible to obtain the correct penetration and fusion of metals.
 - b. Line up the work at a slight angle opposite the direction of distortion during cooling to ensure correct alignment.
 - c. Use skip or step-back method of welding.
 - d. Use clamps to prevent movement.
5. Methods of Reducing or Relieving Stress
- a. Run the weld bead from the fixed end to free end.
 - b. Use the round end of a ball peen hammer to peen the weld lightly as it cools.
 - c. Heat treat the welded material and then allow slow cooling

ACTIVITY:

1. Perform a corner weld without filler rod and have students practice the weld.
2. Perform a bead weld and butt weld with filler rod and have students practice the welds.

OXYACETYLENE CUTTING

A. Oxyacetylene Cutting Process and Applications

1. Oxyacetylene Cutting Process:

- a. Oxyacetylene cutting is a rapid oxidation or burning of metal at high temperature.
- b. Oxidation is the combining of oxygen with any other substance
 - 1) When oxygen slowly combines with a substance, the process is called oxidation.
 - 2) When oxygen rapidly combines with a substance, the process is called burning.
- c. This rapid oxidation process is accomplished by gas flame accompanied by a jet action which blows the oxides away from the cut.

2. Oxyacetylene Cutting Applications:

- a. The process can be applied to all carbon steels up to 0.25% carbon.
- b. The process can also be applied to higher carbon steels, but only with some difficulty.
- c. The process cannot be applied to copper, aluminum, or high-nickel alloys.

B. Oxyacetylene Cutting Equipment

1. Basic oxyacetylene welding apparatus with a cutting torch attachment is used for cutting.

2. Cutting torch valves:

- a. Cutting torch (blow pipe) oxygen and fuel valves
 - 1) The fuel valve adjusts the flow of acetylene into the preheat section of the cutting torch attachment.
 - 2) The oxygen valve on the welding torch (blowpipe) is left fully open to supply the attachment with both preheat and cutting oxygen.
- b. Cutting torch attachment preheat-oxygen valve

- 1) This valve adjusts the flow of oxygen into the preheat section of the cutting torch attachment.
- 2) Oxygen is supplied through a different tube than that which supplies the cutting-oxygen valve.

c. Cutting torch attachment cutting-oxygen valve

- 1) This valve injects pure oxygen into the cut when its lever is depressed.
- 2) The resulting set action greatly increases combustion and removes the molten metal and oxides from the cut.

3. Cutting Tip

- a. It is designed to accommodate both an oxyacetylene preheat flame and a jet stream of pure oxygen for cutting.
- b. It has smaller holes surrounding a larger center orifice.

- 1) The small holes direct the mixed gases into the preheat flame.
- 2) The larger center orifice permits the jet action of pure oxygen from a separate oxygen tube in the attachment.

c. The tip should be cleaned regularly as it becomes clogged with metallic particles during use.

- 1) Use a tip cleaner that is equal to or smaller in size than the tip holes.
- 2) Use an up-and-down motion; do not twist the tip cleaner in the tip holes.

C. Oxyacetylene Cutting Equipment Setup and Operation

1. Cutting Equipment Setup

- a. Attach the cutting attachment to the welding torch and hand tighten the fittings.
- b. Select the proper cutting tip size for the job and inspect the taper cone seat to be sure it is not damaged and is free of dirt.
- c. Insert the cutting tip into the tip nut, screw it onto the cutting attachment, and then tighten it with the appropriate wrench.

2. Cutting Torch Pressurization

- a. Loosen pressure adjusting screws on the regulators.

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- b. Open the oxygen cylinder valve slowly and completely.
- c. Acetylene cylinder valve.
 - 1) Open the valve slowly one half turn (one turn maximum).
 - 2) Never use over 15 psi.
- d. Open the torch (blow pipe) oxygen valve completely.
- e. Set working pressures according to tip size with the gas flowing.
 - 1) Set the recommended oxygen hose pressure by opening the preheat oxygen valve and adjusting the pressure with the oxygen regulator screw.
 - 2) Set the recommended acetylene hose pressure by opening the torch acetylene valve and adjusting the pressure with the acetylene regulator screw.
- f. Purge (blow out) the cutting oxygen passages by depressing the cutting torch oxygen lever before lighting the torch.

3. Cutting Torch Lighting and Adjustment

- a. Open the acetylene valve 1/2 turn and light the torch tip.
 - 1) Add acetylene until the smoke stops and the flame is about 1/8 inch from the tip.
 - 2) Reduce the acetylene until the flame touches the tip.
- b. Open the preheat oxygen valve on the attachment and adjust to a neutral flame.
- c. Depress the cutting-oxygen lever and readjust to a neutral flame.

4. Cutting Equipment Shutdown

- a. Close the preheat valves.
 - 1) Close the preheat-oxygen valve on the attachment first to avoid popping.
 - 2) Then close the acetylene valve on the torch (blow pipe).
- b. Close both cylinder valves.
- c. Open the acetylene valve to bleed the acetylene gauges, hose, and torch, and then close it.

- d. Open the preheat-oxygen valve on the attachment to bleed the oxygen gauges and hose, and to purge the torch.
- e. Loosen the regulator adjustment screws.

D. Oxyacetylene Cutting Procedure

1. Cutting a straight line

- a. Set the metal to be cut on a cutting table and mark a straight line on it with soapstone or clamp a length of angle iron on the line to guide the tip.
 - 1) For a perpendicular cut, place one side of the angle iron on the surface of the metal so that the other side forms a 90-degree angle to the surface.
 - 2) For a bevel cut, place the edges of the two outside surfaces of the angle iron on the metal surface so the surface aligned with the cutting line forms a 45-degree angle.
- b. Select appropriate cutting tip size for metal thickness.
- c. Adjust gas pressures according to tip size selected.
- d. Light torch and adjust flame.
- e. Hold the torch with one hand and guide it with the other, keeping the preheat cone 1/16 to 1/8 inch above the metal surface.
- f. Heat the edge of the metal to a cherry red.
- g. Depress the cutting-oxygen lever slowly.
- h. When the cut starts, continue it by moving the cutting tip along the line keeping the preheat cones just above the metal surface.

1) Cutting angle to direction of travel

- a) For thick metal, the preheat cones are kept perpendicular to the direction of travel.
- b) For thin metal, the preheat cones are slightly angled in the direction of travel.

2) Cutting speed

- a) Moving too slow will allow the metal to refuse at the bottom of the cut.
- b) Moving too fast will cause the metal edges to lose heat and halt the cut.

- h. If the cut is lost, release the cutting-oxygen lever and reheat the metal before proceeding.

2. Piercing holes

- a. Preheat the spot by keeping the preheat cones slightly above the metal surface.
- b. Lift the torch slightly and slowly depress the cutting-lever.
- c. Tilt the torch slightly to blow the sparks away.
- d. Continue to feed cutting oxygen onto the spot until the hole is pierced in the metal.

ACTIVITY:

1. Identify which metals can be cut with an oxyacetylene torch.
2. Select appropriate cutting tip, gas pressures, flame for metal size being cut.
3. Cut a straight line in 1/8 and 1/2 inch mild steel plate.
4. Make a straight bevel cut in 1/2 inch mild steel plate.
5. Cut sheet metal (14 gauge or less).
6. Pierce a hole in 1/8 inch mild steel plate.

References:

Cooper, Elmer L. (1987). AGRICULTURAL MECHANICS: FUNDAMENTALS AND APPLICATIONS. Albany, NY: Delmar Publishers.

Resources:

Deere & Company. (1987). WELDING (6th ed.) (Fundamentals of Service (FOS) Series). Available from: John Deere Technical Services, Dept. F, John Deere Road, Moline, IL 61265 (Available in Spanish)

Special Material and Equipment:

Oxygen and acetylene cylinders, regulators and hoses, torch, tips, open-end wrench, striker, gloves, goggles, and protective clothing filler rods, 1/8 & 1/16 inch mild steel.

Name _____

Date _____

Score _____

UNIT EXAM, OXYACETYLENE WELDING AND CUTTING

Answer the following true and false questions, T if the statement is true and F if the statement is false.

1. _____ A pop will always be heard if the torch acetylene is turned off first when shutting down the torch.
2. _____ Acetylene outlets have a right-handed threads.
3. _____ Acetylene is very soluble in acetone.
4. _____ Gas regulators increase low cylinder pressure to high hose pressure.
5. _____ The pressure adjusting screw on a gas regulator should be turned counterclockwise (out) to decrease the pressure.
6. _____ Keep gloves and protective clothing free of oil and grease to avoid combustion if oxygen comes into contact them.
7. _____ Fumes from a cutting or welding galvanized metal are toxic.
8. _____ Cylinders may be lifted by their valves if care is taken not to drop them.
9. _____ The oxygen tank may be used as a pressure supply to inflate tires or blow off surfaces as long as a acetylene is not mixed.
10. _____ Use soapy water from a soap that does not contain oil to find gas leaks.
11. _____ Never cut or weld on concrete because overheated concrete may crack and explode.
12. _____ In an oxidizing flame, the inner cone will be shorter and the flame will be more noisy than the neutral flame.
13. _____ A bead may be run without a filler rod.
14. _____ Brazing uses the same welding apparatus as oxyacetylene welding.
15. _____ Bronze filler rods usually have a higher melting point than the metal being bonded.

Match the following descriptions with the best possible answer.

- | | | |
|-----------|--|-------------------------|
| 16. _____ | Joining metal pieces by melting them together. | A. Work angle |
| 17. _____ | The filler rod precedes the torch in the direction of the weld | B. Oxidation |
| 18. _____ | The torch tip precedes the filler rod in the direction of the weld. | C. Backfire |
| 19. _____ | The angle of the torch or filler rod perpendicular to the direction of the welding bead. | D. Flashback |
| 20. _____ | The angle of the torch or filler rod parallel to the direction of welding bead | E. Fusion Welding |
| 21. _____ | The momentary burning back of the flame into the tip ending in a loud pop (explosion at the tip) | F. Backhand Welding |
| 22. _____ | An explosion occurring at the tip accompanied by gasses burning back into the hoses and regulator (shrill squealing or hissing). | G. Forehand Welding |
| 23. _____ | The bonding of two metal objects by adhesion with a minimum of alloy. | H. Lead Angle |
| 24. _____ | The combining of oxygen with any other substance. | I. Oxyacetylene Cutting |
| 25. _____ | The rapid oxidation or burning of metal at high temperatures. | J. Brazing |

Multiple Choice

26. _____ Which is not a true description of oxygen?
- a. Oxygen is a colorless gas
 - b. Oxygen has no smell or taste.
 - c. Oxygen is flammable
 - d. Oxygen readily supports combustion

27. _____ Which is NOT a true description of acetylene?
- a. Acetylene is a colorless gas.
 - b. Acetylene has no smell.
 - c. Acetylene is flammable
 - d. Acetylene is explosive when compressed above 15 psi.
28. _____ Which of the following statements about oxyacetylene cutting applications is not true?
- a. It can be applied to all carbon steels up to 0.25% carbon.
 - b. It can also be applied to higher carbon steels, but only with some difficulty.
 - c. It can be applied to copper, aluminum, or high-nickel alloys.
29. _____ Which range does an oxygen cylinder gauge read?
- a. 0 – 30 psi
 - b. 0 – 200 psi
 - c. 0 – 400 psi
 - d. 0 – 4000 psi
30. _____ Which range does an acetylene working gauge read?
- a. 0 – 30 psi
 - b. 0 – 200 psi
 - c. 0 – 400 psi
 - d. 0 – 4000 psi
31. _____ Which range does an oxygen working gauge read
- a. 0 – 30 psi
 - b. 0 – 200 psi
 - c. 0 – 400 psi
 - d. 0 – 4000 psi
32. _____ Which range does an acetylene cylinder gauge read
- a. 0 – 30 psi
 - b. 0 – 200 psi
 - c. 0 – 400 psi
 - d. 0 – 4000 psi
33. _____ Which is the best description of a carbonizing flame?
- a. Excess amount of oxygen.
 - b. Excess amount of acetylene.
 - c. Equal amounts of oxygen and acetylene.

Answer Sheet

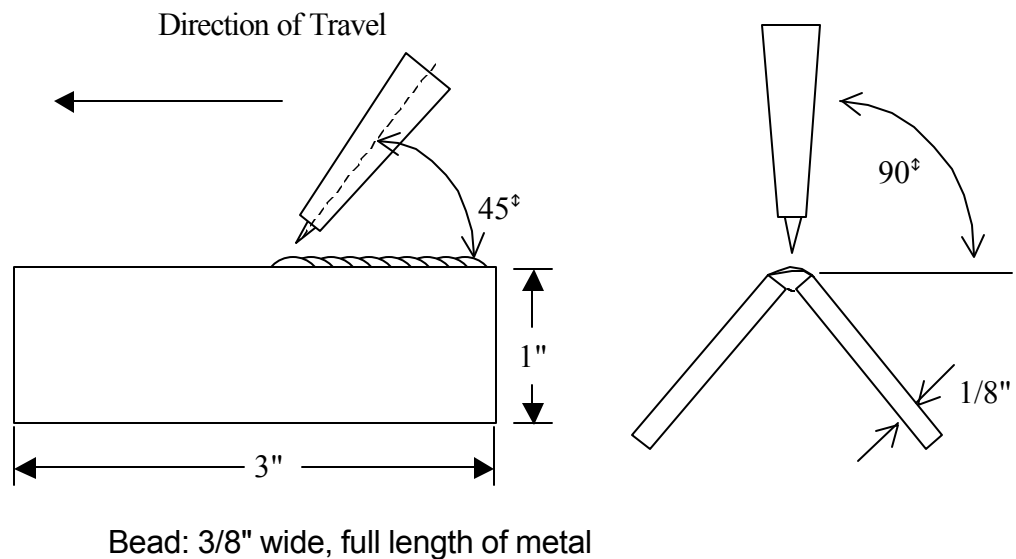
1. T
2. F
3. T
4. F
5. T
6. T
7. T
8. F
9. F
10. T
11. T
12. T
13. T
14. T
15. F

16. E
17. G
18. F
19. A
20. H
21. C
22. D
23. J
24. B
25. I

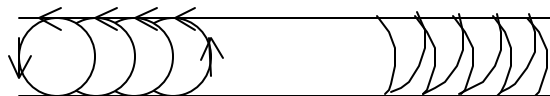
26. C
27. B
28. C
29. D
30. A
31. B
32. C
33. B

Fusion Weld Without Rod

1. Suggested tip, use manufactures' chart (#0 for Victor).
2. Use assigned metal.
3. Set gauges, see chart (victor equipment, 5 psi oxy and 5 psi acet).
4. Maintain about 1/8" between cone & puddle.
5. Maintain 45° travel angle, 90° work angle.
6. Tip should point straight with direction of welding.



7. Use circular or semi-circular motion.

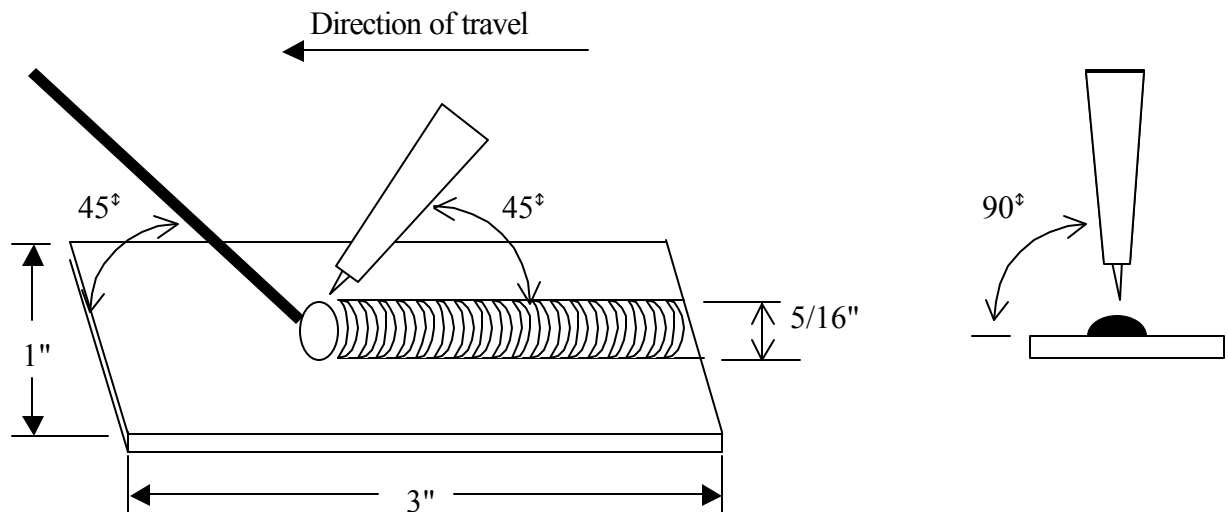


8. Right handed persons start on the right side – work towards left
9. Methods to control heat.
 - A. Change tip size – for more heat , larger tip
 - B. Change flame angle – for more heat, straighter up and down
 - C. Change speed of travel – for more heat, slow down
 - D. Change flame to puddle distance – for more heat, get closer

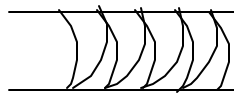
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Fusion Bead Weld, With Rod

1. Suggested tip, use manufactures' chart (#0 or #1 for Victor).
2. Use two pieces of the assigned metal.
3. Set gauges, see chart (for Victor equipment, 5 psi oxy and 5 psi acet).
4. Maintain about 1/8" between cone & puddle.
5. Maintain 45° torch angle, 90° work angle.
6. Use filler rod approximately same diameter as metal thickness.
7. Maintain a 45° rod angle and use slight up and down motion into the puddle.
8. Tip should point straight in direction of welding.



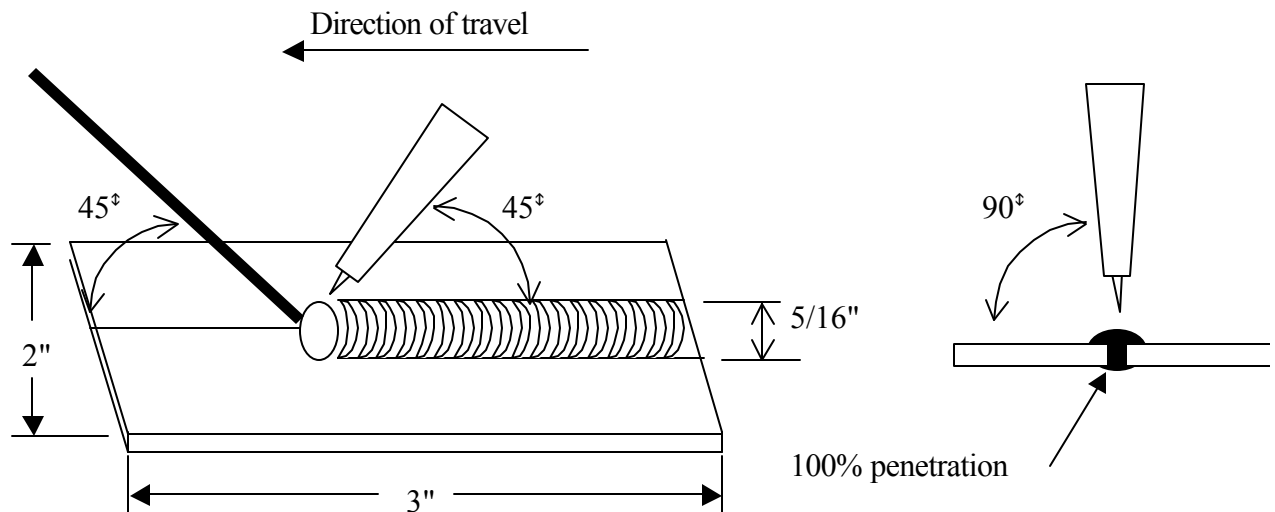
9. Use semi-circular motion with the torch



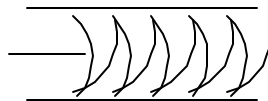
- 10 Right handed persons start on the right side – work towards left
- 11 Methods to control heat.
 - A. Change tip size – for less heat, use smaller tip
 - B. Change flame angle – for less heat, use more angle
 - C. Change speed of travel – for less heat, speed up
 - D. Change flame to puddle distance – for less heat, get farther away

Fusion Butt Weld, With Rod

1. Suggested tip, use manufactures chart (#0 or #1 for Victor).
2. Use assigned metal.
3. Set gauges, see chart (for Victor equipment, 5 psi oxy and 5 psi acet).
4. Maintain about 1/8" between cone & puddle.
5. Maintain 45° torch angle, 90° work angle.
6. Start with a 1/16" gap on the starting end and 1/8" on the finishing end.
7. Use filler rod approximately same diameter as metal thickness.
8. Maintain a 45° rod angle and use slight up and down motion into the puddle, keeping the bead equal on both sides of the joint.
9. Tip should point straight in direction of welding.



10. Use semi-circular motion with the torch.

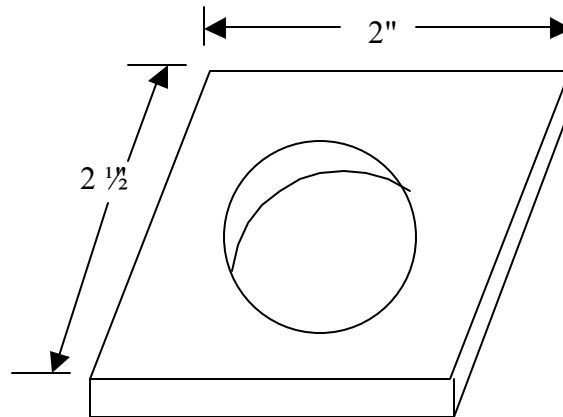


11. Right handed persons start on the right side – work towards left
12. Methods to control heat.
 - A. Change tip size.
 - B. Change flame angle.
 - C. Change speed of travel
 - D. Change flame to puddle distance

Oxyacetylene Cutting

1. Choose proper tip from chart, clean tip frequently.
2. Set oxy-acet pressure according to chart.
3. Light torch – turn up acet until smoke clears or until flame leaves tip then turn down until the flame is back on the tip.
4. Adjust to neutral flame, depress oxy-lever and adjust again.
5. Torch should produce cutting lance about 6" long.
6. Preheat, when edge of metal turns red, gently depress cutting lever to full-on position.

Use 3/8" to 5/8" steel



7. Move as rapidly and steadily as possible without losing cut; observe spark steam – sparks go straight down with proper speed.
8. Torch tip should be held vertical to plate with tips of preheat flames 1/8" above metal.
9. When making practice cuts, cool between each cut.

SPECS:

1. Do not grind the end to be graded.
2. Use chipping hammer and wire brush.
3. Cut hole in the center _____ inch (es) in diameter.
4. Pipe must slide thru hole easily.
5. Cuts to be straight & square with side.
6. To have no slag or top edge melting.

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OXYACETYLENE CUTTING TORCH

CUTTING OXYGEN VALVE LEVER

PREHEAT OXYGEN VALVE

TORCH OXYGEN VALVE

